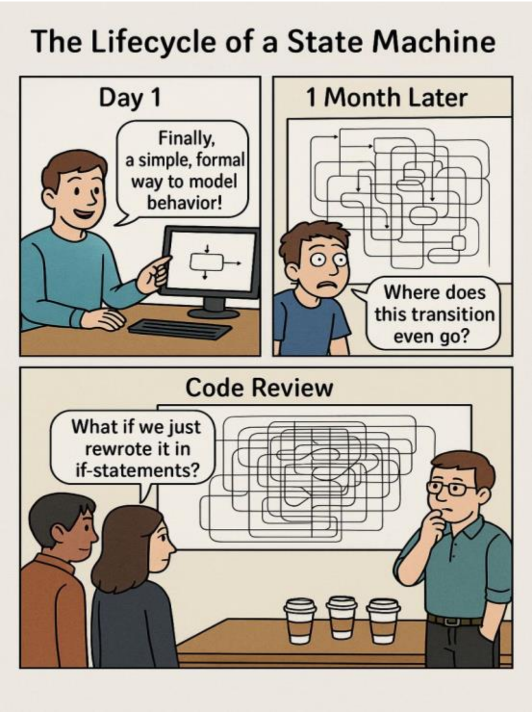
REVIEW OF "SEMANTICAL CHALLENGES IN FRAM WHILE DEVELOPING THE FRAMIFIER" BY BOTS & ADRIAENSEN (2025)

Reviewer: [D. Slater}



Summary

The paper *"Semantical Challenges in FRAM While Developing the FRAMifier"* presents a novel contribution to the FRAM (Functional Resonance Analysis Method) community by proposing the FRAMifier—an open-source browser-based modeling tool aimed at enforcing syntactic and semantic consistency in FRAM models. The authors identify four core challenges in current FRAM practice: abstraction hierarchy logic, computation of aspects, scope of aspects, and temporal representation. They describe the FRAMifier's internal design philosophy, which prioritizes formal rules, expression-based computation, and interface affordances to support syntactically and semantically valid model construction.

After Joel Thurlby

Contribution and Strengths

The authors are to be commended for their clear identification of real-world modeling difficulties encountered by practitioners of FRAM, particularly those involving large or complex system representations. Their discussion is framed around pragmatic concerns, including the "spaghetti effect" in unstructured models, ambiguous coupling semantics, and the challenge of capturing temporal dependencies.

One of the strongest contributions of the paper is its practical framing of design decisions in the FRAMifier as *semantic commitments*, open to community interrogation and revision. By doing so, the authors foster a constructive dialogue about tool support and methodological clarity in FRAM applications.

Noteworthy technical features of the FRAMifier include:

- A hierarchical function decomposition framework, visually and structurally compatible with Patriarca et al.'s abstraction-based FRAM extensions.
- A rule-based logic mechanism allowing modelers to define expressions for function activation, both at the level of functions and their aspects.
- Explicit support for time logic using operators like after, until, and symbolic references such as now and last, enabling conditional activation based on simulated time cycles.

These design elements offer the potential to make FRAM modeling more structured and computationally tractable, particularly in pedagogical settings or simulation environments.

Critical Evaluation

Despite its technical merit, the FRAMifier represents a substantial departure from the foundational epistemology and intent of the FRAM methodology as articulated by Hollnagel (2012, 2017). FRAM is grounded in the principles of emergence, non-linearity, and functional variability, with a philosophical orientation toward *descriptive modeling* rather than *prescriptive simulation*. It is designed to support interpretive reasoning about how functions may variably succeed or fail depending on contextual dependencies, not to produce deterministic simulations.

The FRAMifier's formalization of aspect logic, activation conditions, and time progression introduces a simulation logic that risks undermining FRAM's core strength: its capacity to represent human and organizational variability without imposing rigid flowchart-like behaviour. In enforcing syntactic and semantic constraints via GUI affordances, the tool may unintentionally restrict the reflective and exploratory modeling that is essential to FRAM's use in resilience engineering and accident investigation.

In particular, several methodological concerns arise:

1. **Hierarchical Structuring**
   While drawing parallels to IDEF0, (Integrated Computer aided Manufacturing Definition for Functional Modelling), the imposed constraint that each function has a single parent contradicts the non-decomposability principle in FRAM. Functionality in socio-technical systems is often context-sensitive, and the fixed hierarchical views may obscure rather than clarify emergent couplings.

2. **Aspect Attribution and Expression Logic**
   The use of logic expressions embedded directly in aspect definitions introduces formalism at odds with FRAM's flexible, qualitative reasoning. Although expressions provide computational elegance, they risk reifying behaviour in a way that precludes the human judgment central to the method.

3. **Temporal Formalization**
   The mechanism for advancing time in discrete simulation steps, while technically coherent, introduces a notion of sequential causality not present in traditional FRAM applications. This may inadvertently encourage users to interpret FRAM models as temporal process flows, rather than as constellations of variable interdependencies.

4. **Downplaying Metadata and FMI**
   The paper positions FRAMifier's internal logic as a preferable alternative to the metadata-driven approach implemented in the FMV and FRAM Model Interpreter (FMI). However, metadata affords critical *separation of concerns*, allowing analysts to preserve model flexibility while tailoring interpretations. Replacing this with fixed logic expressions potentially conflates structure and meaning in ways that undermine adaptability.

Recommendation

The FRAMifier should not be interpreted as a replacement for the FRAM Model Visualiser or as a definitive evolution of the FRAM methodology. Rather, it offers a promising complementary tool for specific use cases:

- **Educational scaffolding**, where rigid syntax can guide learners through the modeling discipline.
- **Prototype simulations**, where testable activation logic is desirable.
- **Controlled industrial settings**, where high model formalism is acceptable and system behaviour is tightly bounded.

It would be advisable for future development to more explicitly position the FRAMifier as an *adjunct framework* or *didactic scaffold* rather than as a semantic corrective to FRAM itself. Engaging with broader discussions on epistemic diversity, pluralistic modeling, and interpretive validity within the FRAM community will enrich the tool's contribution and avoid unintended methodological drift.

Conclusion

This paper presents a significant technical innovation in FRAM tool development, but one that walks a delicate line between enhancing usability and overformalizing a method deliberately designed to embrace ambiguity, variability, and emergence. The FRAMifier's approach is a valuable addition to the FRAM ecosystem when used with clarity about its limits and its role. The authors are encouraged to continue this important line of inquiry in collaboration with the wider FRAM community, particularly in exploring how formal structure can coexist with epistemic flexibility.

References

Hollnagel, E. (2012). *FRAM: The Functional Resonance Analysis Method: Modelling Complex Sociotechnical Systems*. Ashgate Publishing Limited. Available via Google Books

Hollnagel, E. (2017). *FRAM: The Functional Resonance Analysis Method: Modelling Complex Sociotechnical Systems* (1st ed.). CRC Press. https://doi.org/10.1201/9781315255071

Commentary:

- The **2012 book** is the original major publication that introduced FRAM in detail. It explains the theoretical foundations, the modeling notation (functions and their aspects), and includes practical examples such as the cup noodles case.
- The **2017 edition** is a more widely distributed reissue of the same core content under CRC Press (Taylor & Francis), with updated commentary and refinements. It is often cited for both theoretical and practical applications of FRAM.

Both are essential references for any rigorous discussion of FRAM methodology, and any critique (such as that in the FRAMifier paper) should be read in light of Hollnagel's own insistence on variability, emergence, and non-decomposability in system modeling.